Alka-Seltzer® Rainbow

Introduction

Produce a quick and moving rainbow of colors with an Alka-Seltzer® tablet and a little vinegar.

Concepts

- Acid–base reactions
- pH indicators

Materials

Alka-Seltzer, 1 tablet
Sodium hydroxide, NaOH, 0.1 M, 100 mL
Universal indicator, 10 mL
Water, distilled, 350 mL
Vinegar, CH_3CO_2H, 10 mL
Beaker, 600-mL
Graduated cylinders; 500-mL, 100-mL and 10-mL
Stirring rod

Safety Precautions

Sodium hydroxide solution causes skin and eye irritation. Universal indicator is an alcohol-based solution and thus a flammable liquid and vapor. Keep away from heat, sparks, open flames, and hot surfaces. May be harmful if swallowed or in contact with skin. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Measure out approximately 350 mL of distilled water in a 600-mL beaker.
2. Add 100 mL of 0.1 M sodium hydroxide solution.
3. Add 10 mL of the universal indicator solution and stir. The solution should now be a dark purple.
4. Pour the solution into a 500-mL graduated cylinder.
5. Use a clean graduated cylinder to measure out 10 mL of vinegar.

Procedure

1. Drop an Alka-Seltzer tablet into the 500-mL graduated cylinder. Color changes should begin to occur as soon as the first carbon dioxide bubbles are formed.
2. When the tablet rises to the top, add about 10 mL of vinegar to the solution. The solution should now be red on the top.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. All materials may be disposed of according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

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Disciplinary Core Ideas: Middle School
MS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions

Disciplinary Core Ideas: High School
HS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions
HS-PS2 Motions and Stability: Forces and Interactions
PS2.B: Types of Interactions

Science and Engineering Practices
Analyzing and interpreting data
Constructing explanations and designing solutions

Crosscutting Concepts
Patterns
Cause and effect
Structure and function

Tips

- The Alka-Seltzer tablet may be placed in the graduated cylinder before adding the sodium hydroxide solution. The reaction occurs immediately as the solution is added, producing a rainbow of colors with more motion.
- Hydrometer cylinders or 600-mL tall form beakers can also be used. This demonstration can also be scaled down using half the reagents and a 250-mL graduated cylinder.
- To get the best rainbow of colors, add the vinegar as soon as the yellow color appears.

Discussion

The Alka-Seltzer tablets contain sodium bicarbonate and citric acid. As the Alka-Seltzer tablet dissolves in water, the citric acid reacts with the sodium bicarbonate to produce carbonic acid (Equation 1) and carbon dioxide (Equation 2). The carbonic acid then reacts with the basic sodium hydroxide to change the pH of the solution (Equations 3 and 4). As the base is consumed, the solution will slowly become more acidic, resulting in the color changes.

$$HCO_3^- + H^+ \rightarrow H_2CO_3 \qquad \textit{Equation 1}$$

$$H_2CO_3 \leftrightharpoons H_2O + CO_2 \qquad \textit{Equation 2}$$

$$H_2CO_3 + OH^- \rightarrow HCO_3^- + H_2O \qquad \textit{Equation 3}$$

$$HCO_3^- + OH^- \rightarrow CO_3^{2-} + H_2O \qquad \textit{Equation 4}$$

The Alka-Seltzer tablet initially sinks to the bottom of the cylinder. As the carbon dioxide bubbles adhere to the tablet, the tablet begins to rise and eventually floats. The buoyancy of the tablet and the final addition of vinegar (a weak acid) lead to a pH gradient. Universal indicator makes the pH gradient visible and produces the characteristic rainbow of colors.

Acknowledgment

Special thanks to Charles Ophardt, Ph.D., Elmhurst College, Elmhurst, IL, for bringing this demo to our attention.

Materials for *Alka-Seltzer® Rainbow* are available from Flinn Scientific, Inc.

Catalog No.	Description
A0111	Alka-Seltzer Tablets, 24/pkg
S0149	Sodium Hydroxide, 0.1 M, 500 mL
U0001	Universal Indicator, 100 mL
V0005	Vinegar, White, 4 L

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.